* NOTICES *

Bibliography

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(71) [Applicant]
[Identification Number] 000001007
[Name] Canon, Inc.
[Address] 3-30-2, Shimo-maruko, Ota-ku, Tokyo
(72) [Inventor(s)]
[Name] Ito Yoshiaki
[Address] 3-30-2, Shimo-maruko, Ota-ku, Tokyo Inside of Canon, Inc.
(74) [Attorney]
[Patent Attorney]
[Name] Takanashi Yukio

[Translation done.]

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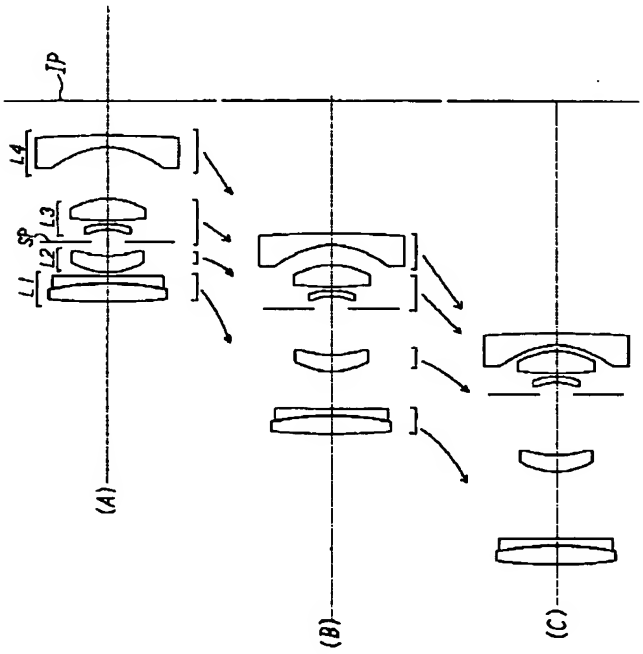
An epitome

(57) [Abstract]
[Technical problem] It has four lens groups as a whole, and obtain small 4 group zoom lens which amended the aberration fluctuation accompanying variable power good.
[Means for Solution] the 1st group of refractive power more negative than a body side to order, the 2nd group of positive refractive power, and the 3rd group of positive refractive power -- and It has four lens groups of the 4th group of negative refractive power, and a gap of this 1st group and the 2nd group and a gap of this 2nd group and the 3rd group should increase on the occasion of variable power from a wide angle edge to a tele edge, and while each lens group moves on an optical axis so that a gap of this 3rd group and the 4th group may decrease, this 2nd group and the 4th group should be moving in one.

[Translation done.]



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CLAIMS

[Claim(s)]
[Claim 1] The 1st group of refractive power more negative than a body side to order, the 2nd group of positive refractive power, the 3rd group of positive refractive power, And have four lens groups of the 4th group of negative refractive power, and a gap of this 1st group and the 2nd group and a gap of this 2nd group and the 3rd group increase on the occasion of variable power from a wide angle edge to a tele edge. A zoom lens characterized by this 2nd group and the 4th group moving in one while each lens group moves on an optical axis so that a gap of this 3rd group and the 4th group may decrease.
[Claim 2] It is the zoom lens of claim 1 which said 4th group consists of a single negative lens which turned a concave surface to a body side, and is characterized by at least one lens side of this negative lens being the aspheric surface of a configuration where negative refractive power becomes weak as it goes to a lens periphery from a lens center.
[Claim 3] Said 3rd group is the zoom lens of claim 1 characterized by having at least one aspheric surface.
[Claim 4] Said 3rd group is the zoom lens of claim 1 characterized by having drawing which moves in one in connection with variable power.
[Claim 5] A zoom lens of claim 4 characterized by moving said 3rd group and performing a focus.

[Claim 6] A zoom lens of claim 1-5 characterized by the whole of the 4th group moving to a body side from said 1st group in the case of variable power from a wide angle edge to a tele edge given in any 1 term.
[Claim 7] A zoom lens of claim 1-6 characterized by satisfying conditions which become 1.1<M1-/M2<1.6 when movement magnitude of said 1st group and 2nd group is respectively set to M1 and M2 on the occasion of variable power from a wide angle edge to a tele edge given in any 1 term.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the zoom lens excellent in the portability aiming at shortening of a lens overall length (distance from the 1st lens side to the image surface) while attaining extensive field angle-ization of a photography field angle especially about the zoom lens of an extensive field angle by the suitable small high variable power for a lens shutter camera, a video camera, etc.
[0002]
[Description of the Prior Art] In the lens shutter camera, the video camera, etc., the small zoom lens with a short lens overall length is demanded with the miniaturization of a camera recently.
[0003] The taking lens with which the miniaturization of a **** camera is progressing and especially a lens shutter camera is equipped in it by development of circumference technology,

such as an electrical circuit for a zoom drive, etc. is also high variable power, and the compact zoom lens is demanded.
[0004] Conventionally, the so-called 2 group zoom lens which consists of two lens groups, positive and negative refractive power, as a zoom lens for lens shutters was in use. since this 2 group zoom lens has a lens configuration and the simple migration device at the time of variable power -- the miniaturization of a camera -- and it is low cost comparatively -- etc. -- there is an advantage.
[0005] However, in order to have to perform a variable power operation only by one lens group, the variable power ratio is about 1.6 to 2 times, and it becomes difficult to maintain high optical-character ability at the same time expanding a variable power ratio by force causes enlargement of a lens system.
[0006] The 1st group is divided into two lens groups of positive refractive power on the basis of 2 group zoom lens, and 3 group zoom lens which aimed at high variable power-ization as 3 group configurations of positive, positive, and negative refractive power as a whole is proposed by JP,3-282409,A, JP,4-37810,A, JP,4-76511,A, etc.
[0007] however, this lens group configuration -- for example, the half-field angle of 35 degrees or more -- extensive -- if it is going to attain a field angle zoom lens system, change of the entrance pupil location at the time of variable power will become large. For this reason, in case high variable power-ization is attained, it becomes very difficult to suppress the aberration fluctuation by variable power.
[0008] In addition, by multi-lens grouping, the half-field angle of a wide angle edge is made into about 38 degrees, a variable power ratio is made into about 3.5 times, and the zoom lens which attained formation of an extensive field angle and high variable power-ization is proposed by JP,2-72316,A and JP,3-249614,A.
[0009] However, both these zoom lens systems have front **** and a large-sized lens overall length, and are not necessarily enough as a taking lens of a compact camera.
[0010] In case it applies to the camera which uses especially an external finder, there is a trouble that a lens barrel will cover the photography visual field of a finder, at the time of a wide angle edge. Moreover, as a result, the trouble of giving finder arrangement and a limit of the gestalt of a camera is also produced.
[0011] Moreover, it consists of four lens groups of negative, positive, and positive and negative refractive power sequentially from a body side, and 4 group zoom lens of a high variable power ratio is comparatively proposed by JP,4-237009,A with the extensive field angle. However, this 4 group zoom lens had much lens number of sheets, and had the orientation for front **** to increase.
[0012] Moreover, although 4 group zoom lens proposed by JP,64-15610,A had the 3-about variable power ratio, a photography field angle was not necessarily enough.
[0013]
[Problem(s) to be Solved by the Invention] High variable power-ization is attained, the movement magnitude of each lens group for obtaining a predetermined variable power ratio decreasing, and attaining shortening of a lens overall length, if the refractive power of each lens group is generally strengthened in a zoom lens. However, if the refractive power of each lens group is only strengthened, in case the aberration fluctuation accompanying variable power will become large and raise in variable power and extensive field angle-ization will be attained especially, the trouble that it becomes difficult to obtain optical-character ability with a good rear spring supporter is in all variable power ranges.
[0014] constituting this invention from four lens groups as a whole, and setting up appropriately migration conditions, refractive power, etc. of each lens group in variable power -- the photography field angle of a wide angle edge -- about 70 degrees and a variable power ratio -- all the variable power ranges that are about 3.0 -- a rear spring supporter -- it aims at offer of a zoom lens with high optical-character ability.
[0015]
[Means for Solving the Problem] The 1st group of refractive power more negative than a body side to order in a zoom lens of this invention, the 2nd group of positive refractive power, It has

four lens groups of the 3rd group of positive refractive power, and the 4th group of negative refractive power. On the occasion of variable power from a wide angle edge to a tele edge, a gap of this 1st group and the 2nd group and a gap of this 2nd group and the 3rd group increase, and while each lens group moves on an optical axis so that a gap of this 3rd group and the 4th group may decrease, this 2nd group and the 4th group are characterized by moving in one.
[0016]
[Embodiment of the Invention] Drawing 1 - drawing 3 are the lens cross sections of the numerical examples 1-3 of this invention respectively. In drawing 1 - drawing 3 , in (A), a wide angle edge and (B) show middle, and (C) shows the tele edge. Drawing 4 - drawing 6 are [many aberration drawings of the numerical example 2 of this invention, drawing 10 - drawing 12 of many aberration drawings of the numerical example 1 of this invention, drawing 7 - drawing 9] many aberration drawings of the numerical example 3 of this invention.
[0017] The 1st group of refractive power negative in L1, the 2nd group of refractive power positive in L2, the 3rd group of refractive power positive in L3, and L4 are the 4th group of negative refractive power among drawing. An arrow head shows the migration direction of each lens group at the time of performing variable power from a wide angle side to a looking-far side. SP extracts and IP is the image surface.
[0018] With this operation gestalt, on the occasion of the variable power from a wide angle edge to a tele edge, the gap of the 1st group and the 2nd group and the gap of the 2nd group and the 3rd group increase, and each lens group is moved to the optical-axis up body side so that the gap of the 3rd group and the 4th group may decrease. The miniaturization of the whole lens system is in drawing, this attaining effectively a predetermined variable power ratio and extensive field angle-ization.
[0019] This invention constitutes the 1st group L1 of especially negative refractive power from two lenses of the negative lens with which both the lens side turned the concave surface to the convex positive lens and body side in order from a body side. The 2nd group L2 of positive refractive power is constituted from one lens of the positive lens of the shape of a meniscus which turned the convex to the body side. Meniscus-like the negative lens and both the lens side which turned the convex to the image surface side constitute the 3rd group L3 of positive refractive power from two lenses of a convex positive lens, and the 4th group L4 of negative refractive power consists of one lens of the negative lens of the shape of a meniscus which turned the convex to the image surface side. This securing a predetermined variable power ratio, the aberration fluctuation accompanying variable power was amended good, and high optical-character ability has been obtained over all variable power ranges.
[0020] Moreover, said 4th group consisted of the single negative lens which turned the concave surface to the body side, and at least one lens side of this negative lens was constituted from the aspheric surface of a configuration where negative refractive power becomes weak as it went to the lens periphery from the lens center, it amended the aberration fluctuation accompanying variable power, and has amended aberration outside a shaft, such as a curvature of field and distortion aberration, good especially. He is trying for **** 3 group to have at least one aspheric surface. This has amended the aberration fluctuation in the case of variable power and a focus good.
[0021] Drawing SP made it move in one with the 3rd group in connection with variable power, and has prevented increase of the lens outer diameter of each lens group. **** 3 group is moved, a focus is performed and aberration fluctuation in the case of a focus is lessened.
[0022] In the case of the variable power from a wide angle edge to a tele edge, as the whole of the 4th group moves to a body side from said 1st group, shortening of the lens overall length in a wide angle edge is attained, and the miniaturization of the whole camera at the time of un-using it is in drawing.
[0023] When movement magnitude of said 1st group and 2nd group is respectively set to M1 and M2 on the occasion of the variable power from a wide angle edge to a tele edge, it is
$1.1<M1/M2<1.6$. ..... (1)
He is trying to satisfy the becoming conditions.
[0024] Conditional expression (1) is a thing for amending a curvature of field good, mainly

attaining shortening of a lens overall length about the ratio of the movement magnitude of the 1st group accompanying variable power, and the 2nd group. If the movement magnitude of the 1st group increases compared with the 2nd group exceeding the upper limit of conditional expression (1), since the lens overall length in a tele edge will become long, it is not good.
[0025] Moreover, if the movement magnitude of the 1st group decreases exceeding the lower limit of conditional expression (1), it will become difficult to amend the aberration fluctuation accompanying variable power, especially fluctuation of the chromatic aberration of magnification good.
[0026] In addition, it is the numerical range of conditional expression (1) still more preferably
1.2<M1/M2<1.4 ..... (1a)
** -- it is good to set up like.
[0027] Next, the numerical example of this invention is shown. a numerical example -- setting -- Ri -- a body side -- the i-th lens thickness and an air gap, nickel, and nui are the radius of curvatures of the i-th lens side, and Di is the refractive index and the Abbe number of glass of the i-th lens in order from an each body side in a body side. Moreover, an aspheric surface configuration is [0028], when the radius of curvature of the core of a lens side was set to R, the X-axis was set as the direction of an optical axis (travelling direction of light), a Y-axis is set as an optical axis and a perpendicular direction and B, C, D, and E are respectively made into an aspheric surface coefficient.
[Equation 1]

$$X=\frac{(1/R)\,Y^2}{1+\sqrt{1-(1+K)\,(Y/R)^2}}+BY^4+CY^6+DY^8+EY^{10}$$

It expresses with the becoming formula. Moreover, "e-X" means "x10-X."
[0029]
[External Character 1]

数値実施例 1

f = 31.10～ 89.16 Fno= 3.91 ～ 8.87 2ω=69.7 ～ 27.3

R 1 =	113.17	D 1 =	3.87	N 1 = 1.516330	ν 1 = 64.2
R 2 =	-56.62	D 2 =	0.15		
R 3 =	-51.75	D 3 =	1.50	N 2 = 1.805181	ν 2 = 25.4
R 4 =	-1251.5	D 4 =	可変		
R 5 =	13.85	D 5 =	3.47	N 3 = 1.621021	ν 3 = 35.3
R 6 =	20.28	D 6 =	可変		
R 7 =	絞り	D 7 =	2.65		
R 8 =	-8.97	D 8 =	1.25	N 4 = 1.805181	ν 4 = 25.4
R 9 =	-12.60	D 9 =	0.70		
R10 =	56.47	D10 =	4.71	N 5 = 1.583126	ν 5 = 59.4
* R11 =	-12.20	D11 =	可変		
* R12 =	-12.63	D12 =	2.51	N 6 = 1.677900	ν 6 = 55.3
R13 =	-180.39				

焦点距離 / 可変間隔	31.10	59.67	89.16
D 4	0.85	7.95	14.17
D 6	2.97	9.93	12.88
D11	11.18	4.23	1.28

非球面係数

11面

A=0 B=1.026 e-04 C=-2.281 e-07 D=2.601 e-08 E=-2.721 e-10

12面

k=-4.937 e-01 A=0 B=5.503 e-05 C=4.380 e-07 D=-4.160 e-09 E=1.243 e-11

[0030]
[External Character 2]

数値実施例 2

f = 31.10～ 89.16 Fno = 3.91 ～ 8.71 2ω=69.7 ～ 27.3

R 1 =	92.25	D 1 =	3.87	N 1 = 1.516330	ν 1 = 64.2
R 2 =	-56.53	D 2 =	0.13		
R 3 =	-53.69	D 3 =	1.50	N 2 = 1.805181	ν 2 = 25.4
R 4 =	-975.07	D 4 =	可変		
R 5 =	18.36	D 5 =	3.47	N 3 = 1.621021	ν 3 = 35.3
R 6 =	19.12	D 6 =	可変		
R 7 =	絞り	D 7 =	2.65		
R 8 =	-8.89	D 8 =	1.25	N 4 = 1.805181	ν 4 = 25.4
R 9 =	-12.54	D 9 =	0.80		
R10 =	57.05	D10 =	4.71	N 5 = 1.583126	ν 5 = 59.4
* R11 =	-12.36	D11 =	可変		
* R12 =	-12.92	D12 =	2.51	N 6 = 1.677900	ν 6 = 55.3
R13 =	-221.05				

可変間隔＼焦点距離	31.10	59.64	89.16
D 4	0.57	8.54	13.57
D 6	3.02	9.95	12.95
D11	11.19	4.26	1.27

非球面係数

11面

A=0 B=8.944 e-05 C=4.050 e-07 D=8.468 e-09 E=-1.212 e-10

12面

k=-4.367 e-01 A=0 B=5.317 e-05 C=5.018 e-07 D=-5.159 e-09 E=1.630 e-11

[0031]
[External Character 3]

数値実施例 3

f = 31.10～ 89.16 Fno= 3.91 ～ 8.87 2ω=69.7 ～ 27.3

R 1 =	124.77	D 1 =	8.87	N 1 = 1.516330	ν 1 = 64.2
R 2 =	-54.04	D 2 =	0.14		
R 3 =	-49.90	D 3 =	1.50	N 2 = 1.805181	ν 2 = 25.4
R 4 =	-594.11	D 4 =	可変		
R 5 =	13.40	D 5 =	3.47	N 3 = 1.621021	ν 3 = 35.3
R 6 =	20.18	D 6 =	可変		
R 7 =	絞り	D 7 =	2.55		
R 8 =	-9.02	D 8 =	1.25	N 4 = 1.805181	ν 4 = 25.4
R 9 =	-12.86	D 9 =	0.61		
R10 =	58.05	D10 =	4.71	N 5 = 1.583126	ν 5 = 59.4
* R11 =	-12.16	D11 =	可変		
* R12 =	-12.80	D12 =	2.51	N 6 = 1.677900	ν 6 = 55.3
* R13 =	-195.58				

可変間隔＼焦点距離	31.10	59.86	89.16
D 4	1.00	7.70	13.66
D 6	2.98	9.97	12.93
D11	11.23	4.24	1.28

非球面係数

11面

A=0 B=1.020 e-04 C=1.993 e-07 D=1.204 e-08 E=-1.437 e-10

12面

k=-2.715 e-01 A=0 B=5.884 e-05 C=6.269 e-07 D=-4.540 e-09 E=7.058 e-12

13面

A=0 B=-5.780 e-06 C=9.172 e-08 D=-3.838 e-10 E=7.555 e-14

[0032]
[Effect of the Invention] according to this invention, constituting from four lens groups as a whole, and setting up appropriately migration conditions, refractive power, etc. of each lens group in variable power as mentioned above, -- the photography field angle of a wide angle edge -- about 70 degrees and a variable power ratio -- all the variable power ranges that are about 3.0 -- a rear spring supporter -- a zoom lens with high optical-character ability can be attained.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The lens cross section of the numerical example 1 of this invention
[Drawing 2] The lens cross section of the numerical example 2 of this invention
[Drawing 3] The lens cross section of the numerical example 3 of this invention

[Drawing 4] Aberration drawing of the wide angle edge of the numerical example 1 of this invention
[Drawing 5] Middle aberration drawing of the numerical example 1 of this invention
[Drawing 6] Aberration drawing of the tele edge of the numerical example 1 of this invention
[Drawing 7] Aberration drawing of the wide angle edge of the numerical example 2 of this invention
[Drawing 8] Middle aberration drawing of the numerical example 2 of this invention
[Drawing 9] Aberration drawing of the tele edge of the numerical example 2 of this invention
[Drawing 10] Aberration drawing of the wide angle edge of the numerical example 3 of this invention
[Drawing 11] Middle aberration drawing of the numerical example 3 of this invention
[Drawing 12] Aberration drawing of the tele edge of the numerical example 3 of this invention
[Description of Notations]
L1 The 1st group
L2 The 2nd group
L3 The 3rd group
L4 The 4th group
SP Drawing
IP Image surface
d d line
g g line
S Sagittal image surface
M Meridional image surface

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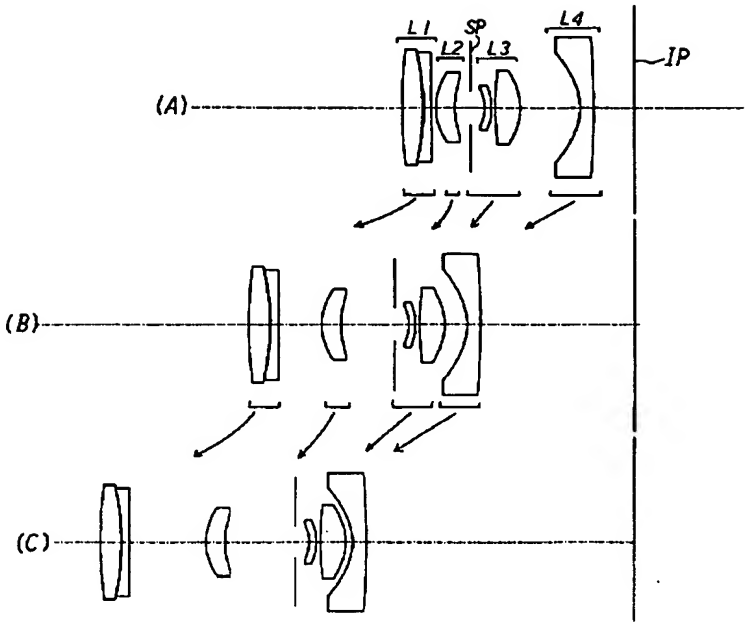
DRAWINGS

[Drawing 1]



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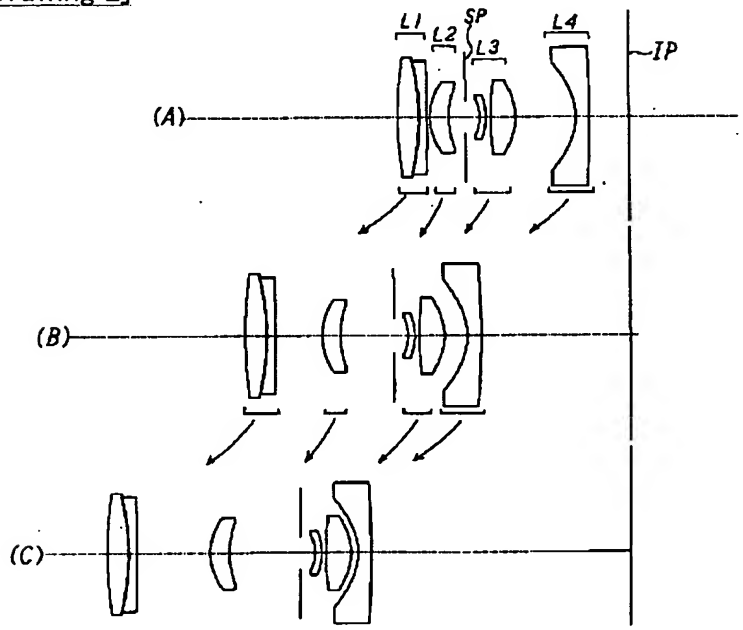

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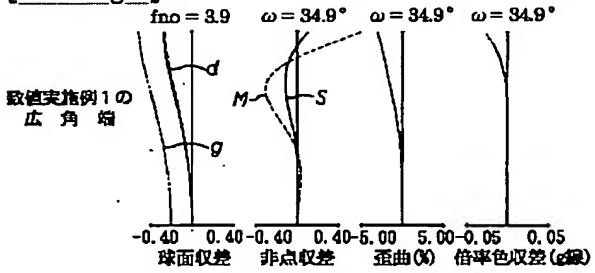

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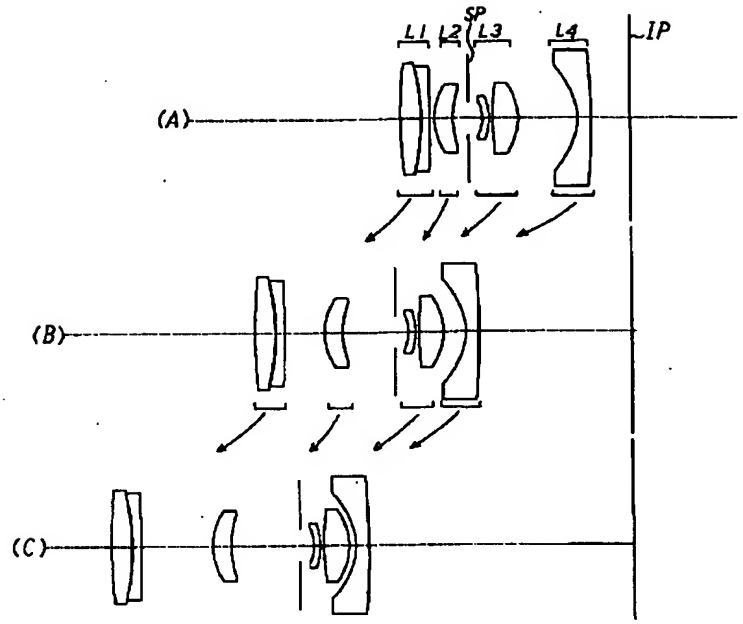

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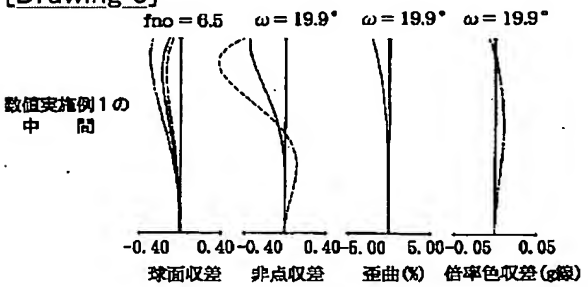

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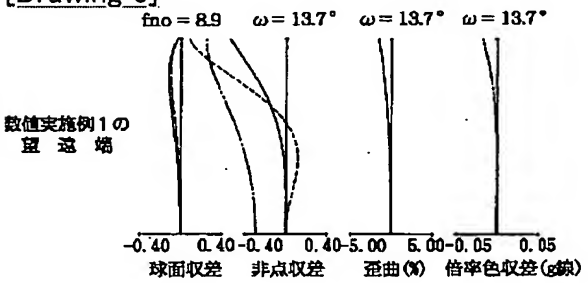

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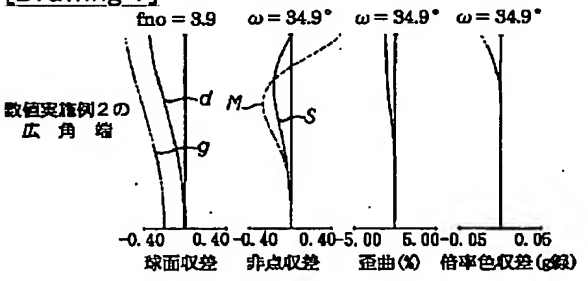

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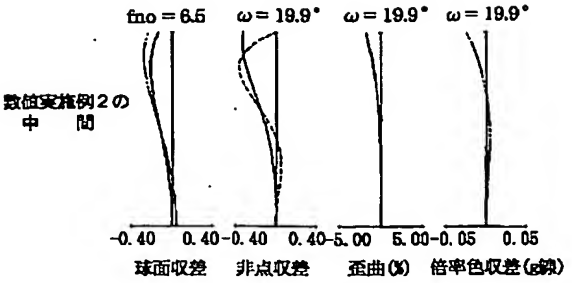

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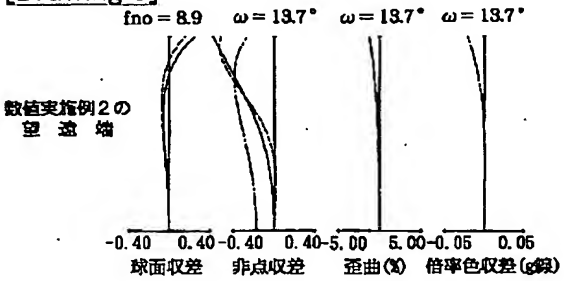
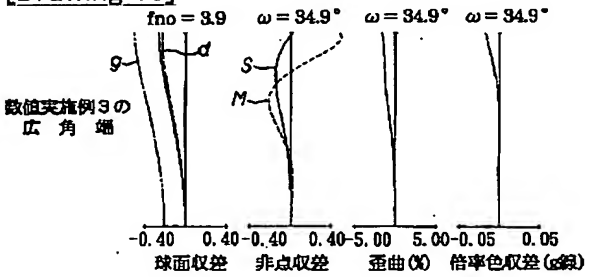


[Drawing 10]



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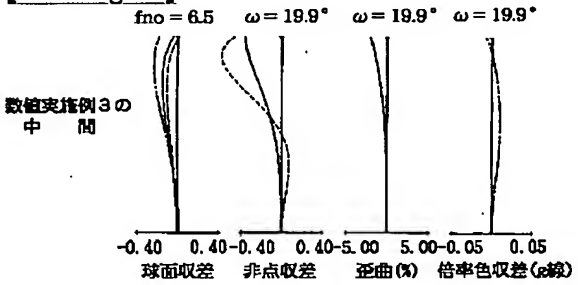

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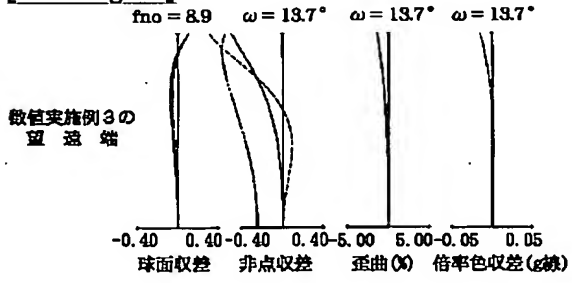

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(43)公開日　平成10年(1998)２月３日

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(71)出願人　000001007
キヤノン株式会社
東京都大田区下丸子３丁目30番２号

(72)発明者　伊藤　良紀
東京都大田区下丸子３丁目30番２号　キヤノン株式会社内

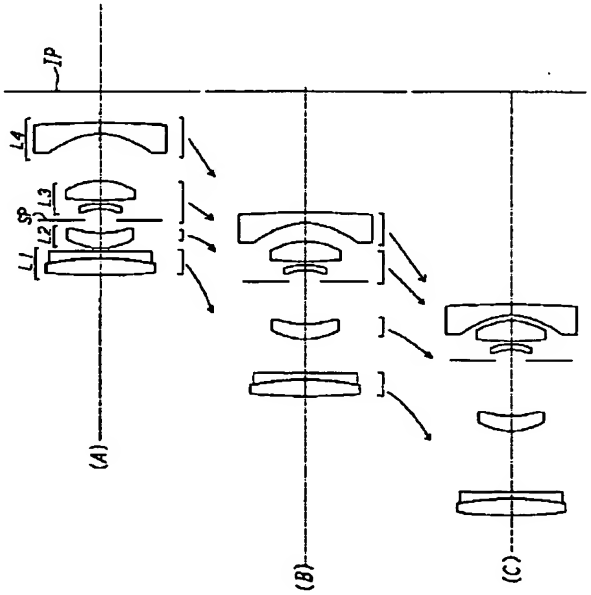
(74)代理人　弁理士　高梨　幸雄

(54)【発明の名称】　ズームレンズ

(57)【要約】

【課題】　全体として４つのレンズ群を有し、変倍に伴う収差変動を良好に補正した小型の４群ズームレンズを得ること。

【解決手段】　物体側より順に負の屈折力の第１群、正の屈折力の第２群、正の屈折力の第３群、そして負の屈折力の第４群の４つのレンズ群を有し、広角端から望遠端への変倍に際して該第１群と第２群の間隔及び該第２群と第３群の間隔が増大し、該第３群と第４群の間隔が減少するように各レンズ群が光軸上移動すると共に該第２群と第４群とが一体的に移動していること。



【特許請求の範囲】
【請求項１】　物体側より順に負の屈折力の第１群、正の屈折力の第２群、正の屈折力の第３群、そして負の屈折力の第４群の４つのレンズ群を有し、広角端から望遠端への変倍に際して該第１群と第２群の間隔及び該第２群と第３群の間隔が増大し、該第３群と第４群の間隔が減少するように各レンズ群が光軸上移動すると共に該第２群と第４群とが一体的に移動していることを特徴とするズームレンズ。
【請求項２】　前記第４群は物体側に凹面を向けた単一の負レンズより成り、該負レンズの少なくとも１つのレンズ面はレンズ中心からレンズ周辺部にいくに従い負の屈折力が弱くなる形状の非球面であることを特徴とする請求項１のズームレンズ。
【請求項３】　前記第３群は少なくとも１つの非球面を有していることを特徴とする請求項１のズームレンズ。
【請求項４】　前記第３群は変倍に伴い一体的に移動する絞りを有していることを特徴とする請求項１のズームレンズ。
【請求項５】　前記第３群を移動させてフォーカスを行っていることを特徴とする請求項４のズームレンズ。
【請求項６】　広角端から望遠端への変倍の際、前記第１群から第４群が全て物体側へ移動していることを特徴とする請求項１～５の何れか１項記載のズームレンズ。
【請求項７】　広角端から望遠端への変倍に際して前記第１群と第２群の移動量を各々Ｍ１，Ｍ２としたとき
１．１＜Ｍ１／Ｍ２＜１．６
なる条件を満足することを特徴とする請求項１～６の何れか１項記載のズームレンズ。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明はレンズシャッターカメラ、ビデオカメラ等に好適な小型の高変倍で広画角のズームレンズに関し、特に撮影画角の広画角化を図ると共にレンズ全長（第１レンズ面から像面までの距離）の短縮化を図った携帯性に優れたズームレンズに関するものである。
【０００２】
【従来の技術】最近レンズシャッターカメラ、ビデオカメラ等においては、カメラの小型化に伴いレンズ全長の短い小型のズームレンズが要求されている。
【０００３】特にレンズシャッターカメラは、ズーム駆動用の電気回路などの周辺技術の発達などにより、増々カメラの小型化が進んでおり、それに備わる撮影レンズも高変倍でかつコンパクトなズームレンズが要求されている。
【０００４】従来、レンズシャッター用のズームレンズとしては正、負の屈折力の２つのレンズ群より成る所謂２群ズームレンズが主流であった。この２群ズームレンズはレンズ構成及び変倍時の移動機構が簡易なため、カメラの小型化及び比較的低コストである等の利点がある。
【０００５】しかしながら変倍作用を１つのレンズ群のみで行わなくてはならないため、その変倍比は１．６～２倍程度であり、無理に変倍比を拡大することはレンズ系の大型化を招くと同時に、高い光学性能を保つことが困難になってくる。
【０００６】２群ズームレンズを基礎とし、第１群を正の屈折力の２つのレンズ群に分離し、全体として正，正，負の屈折力の３群構成として高変倍化を狙った３群ズームレンズが、例えば特開平３－２８２４０９号公報，特開平４－３７８１０号公報．特開平４－７６５１１号公報等で提案されている。
【０００７】しかしながらこのレンズ群構成で例えば半画角３５°以上の広画角なズームレンズ系を達成しようとすると変倍時の入射瞳位置の変化が大きくなる。このため、高変倍化を図る際は変倍による収差変動を抑えることが大変困難になってくる。
【０００８】この他、多レンズ群化により広角端の半画角を３８°程度、変倍比を３．５倍程度とし、広画角化及び高変倍化を図ったズームレンズが、例えば特開平２－７２３１６号公報，特開平３－２４９６１４号公報で提案されている。
【０００９】しかしながら、これらのズームレンズ系は前玉径及びレンズ全長が共に大型であり、コンパクトカメラの撮影レンズとしては必ずしも十分でない。
【００１０】特に外部ファインダーを使用するカメラに適用する際は、広角端時にレンズ鏡筒がファインダーの撮影視野を覆ってしまうという問題点がある。又この結果、ファインダー配置やカメラの形態の制限を与えてしまうという問題点も生じてくる。
【００１１】又物体側から順に負，正，正，そして負の屈折力の４つのレンズ群より成り、比較的広画角で高変倍比の４群ズームレンズが、例えば特開平４－２３７００９号公報で提案されている。しかしながらこの４群ズームレンズはレンズ枚数が多く、前玉径が増大する傾向があった。
【００１２】又、特開昭６４－１５６１０号公報で提案されている４群ズームレンズは変倍比は３程度あるが、撮影画角が必ずしも十分でなかった。
【００１３】
【発明が解決しようとする課題】一般にズームレンズにおいて各レンズ群の屈折力を強めれば所定の変倍比を得る為の各レンズ群の移動量が少なくなり、レンズ全長の短縮化を図りつつ高変倍化が可能となる。しかしながら単に各レンズ群の屈折力を強めると変倍に伴う収差変動が大きくなり、特に高変倍化及び広画角化を図る際には全変倍範囲にわたり良好なる光学性能を得るのが難しくなってくるという問題点がある。
【００１４】本発明は、全体として４つのレンズ群より

構成し、変倍における各レンズ群の移動条件や屈折力等を適切に設定することにより、広角端の撮影画角が７０°程度、変倍比３．０程度の全変倍範囲にわたり高い光学性能を有したズームレンズの提供を目的とする。

【００１５】

【課題を解決するための手段】本発明のズームレンズは、物体側より順に負の屈折力の第１群、正の屈折力の第２群、正の屈折力の第３群、そして負の屈折力の第４群の４つのレンズ群を有し、広角端から望遠端への変倍に際して該第１群と第２群の間隔及び該第２群と第３群の間隔が増大し、該第３群と第４群の間隔が減少するように各レンズ群が光軸上移動すると共に該第２群と第４群とが一体的に移動していることを特徴としている。

【００１６】

【発明の実施の形態】図１～図３は各々本発明の数値実施例１～３のレンズ断面図である。図１～図３において（Ａ）は広角端，（Ｂ）は中間，（Ｃ）は望遠端を示している。図４～図６は本発明の数値実施例１の諸収差図、図７～図９は本発明の数値実施例２の諸収差図、図１０～図１２は本発明の数値実施例３の諸収差図である。

【００１７】図中、Ｌ１は負の屈折力の第１群、Ｌ２は正の屈折力の第２群、Ｌ３は正の屈折力の第３群、Ｌ４は負の屈折力の第４群である。矢印は広角側から望遠側への変倍を行う際の各レンズ群の移動方向を示す。ＳＰは絞り、ＩＰは像面である。

【００１８】本実施形態では広角端から望遠端への変倍に際して、第１群と第２群の間隔及び第２群と第３群の間隔が増大し、第３群と第４群の間隔が減少するように各レンズ群を光軸上物体側へ移動させている。これにより所定の変倍比及び広画角化を効果的に達成しつつ、レンズ系全体の小型化を図っている。

【００１９】特に本発明では物体側より順に負の屈折力の第１群Ｌ１を両レンズ面が凸面の正レンズと物体側に凹面を向けた負レンズの２枚のレンズより構成し、正の屈折力の第２群Ｌ２を物体側に凸面を向けたメニスカス状の正レンズの１枚のレンズより構成し、正の屈折力の第３群Ｌ３を像面側に凸面を向けたメニスカス状の負レンズと両レンズ面が凸面の正レンズの２枚のレンズより構成し、負の屈折力の第４群Ｌ４を像面側に凸面を向けたメニスカス状の負レンズの１枚のレンズより構成している。これにより所定の変倍比を確保しつつ変倍に伴う収差変動を良好に補正し全変倍範囲にわたり高い光学性能を得ている。

【００２０】又、前記第４群は物体側に凹面を向けた単一の負レンズより成り、該負レンズの少なくとも１つのレンズ面はレンズ中心からレンズ周辺部にいくに従い負の屈折力が弱くなる形状の非球面より構成し、変倍に伴う収差変動を補正し、特に像面湾曲や歪曲収差等の軸外収差を良好に補正している。又第３群は少なくとも１つの非球面を有するようにしている。これにより、変倍及びフォーカスの際の収差変動を良好に補正している。

【００２１】絞りＳＰは変倍に伴い第３群と一体的に移動させて、各レンズ群のレンズ外径の増大を防止している。又第３群を移動させてフォーカスを行い、フォーカスの際の収差変動を少なくしている。

【００２２】広角端から望遠端への変倍の際、前記第１群から第４群が全て物体側へ移動するようにして広角端でのレンズ全長の短縮化を図り、不使用のときのカメラ全体の小型化を図っている。

【００２３】広角端から望遠端への変倍に際して前記第１群と第２群の移動量を各々Ｍ１，Ｍ２としたとき

$$1.1 < M1/M2 < 1.6 \quad \cdots\cdots (1)$$

なる条件を満足するようにしている。

【００２４】条件式（１）は変倍に伴う第１群と第２群の移動量の比に関し、主にレンズ全長の短縮化を図りつつ、像面湾曲を良好に補正する為のものである。条件式（１）の上限値を越えて第２群に比べて第１群の移動量が多くなると、望遠端でのレンズ全長が長くなってくるので良くない。

【００２５】又条件式（１）の下限値を越えて第１群の移動量が少なくなってくると、変倍に伴う収差変動、特に倍率色収差の変動を良好に補正するのが難しくなってくる。

【００２６】尚、更に好ましくは条件式（１）の数値範囲を

$$1.2 < M1/M2 < 1.4 \quad \cdots\cdots (1a)$$

の如く設定するのが良い。

【００２７】次に本発明の数値実施例を示す。数値実施例においてＲｉは物体側より順に第ｉ番目のレンズ面の曲率半径、Ｄｉは物体側より第ｉ番目のレンズ厚及び空気間隔、Ｎｉとνｉは各々物体側より順に第ｉ番目のレンズのガラスの屈折率とアッベ数である。又、非球面形状はレンズ面の中心部の曲率半径をＲとし、光軸方向（光の進行方向）をＸ軸とし、光軸と垂直方向をＹ軸、Ｂ，Ｃ，Ｄ，Ｅを各々非球面係数としたとき

【００２８】

【数１】

$$X = \frac{(1/R)\,Y^2}{1+\sqrt{1-(1+K)(Y/R)^2}} + BY^4 + CY^6 + DY^8 + EY^{10}$$

なる式で表している。又「ｅ－Ｘ」は「×１０$^{-X}$」を意味している。

【００２９】

【外１】

数値実施例 1

f = 81.10～ 89.16　Fno= 3.91 ～ 3.87　2ω=69.7 ～ 27.3

R 1 =	113.17	D 1 =	3.87	N 1 = 1.516330	ν 1 = 64.2
R 2 =	-56.62	D 2 =	0.15		
R 3 =	-51.75	D 3 =	1.50	N 2 = 1.805181	ν 2 = 25.4
R 4 =	-1251.5	D 4 =	可変		
R 5 =	13.85	D 5 =	3.47	N 3 = 1.621021	ν 3 = 35.3
R 6 =	20.28	D 6 =	可変		
R 7 =	絞り	D 7 =	2.65		
R 8 =	-8.97	D 8 =	1.25	N 4 = 1.805181	ν 4 = 25.4
R 9 =	-12.60	D 9 =	0.70		
R10 =	56.47	D10 =	4.71	N 5 = 1.588126	ν 5 = 59.4
* R11 =	-12.20	D11 =	可変		
* R12 =	-12.69	D12 =	2.51	N 6 = 1.677900	ν 6 = 55.3
R13 =	-180.39				

焦点距離 / 可変間隔	31.10	56.67	89.16
D 4	0.85	7.95	14.17
D 6	2.97	9.93	12.88
D11	11.18	4.23	1.28

非球面係数

11面

A=0　　B=1.026 e-04　C=-2.261 e-07　D=2.601 e-08　E=-2.721 e-10

12面

k=-4.937 e-01　A=0　B=5.503 e-05　C=4.380 e-07　D=-4.160 e-08　E=1.243 e-11

【００３０】　　【外２】

数値実施例 2

f = 31.10～ 59.16　Fno = 3.91 ～ 6.71　2ω=69.7 ～ 27.3

R 1 =	92.25	D 1 =	3.87	N 1 = 1.516330	ν 1 = 64.2
R 2 =	-56.53	D 2 =	0.13		
R 3 =	-52.69	D 3 =	1.50	N 2 = 1.805181	ν 2 = 25.4
R 4 =	-975.07	D 4 =	可変		
R 5 =	13.36	D 5 =	3.47	N 3 = 1.621021	ν 3 = 35.8
R 6 =	19.13	D 6 =	可変		
R 7 =	絞り	D 7 =	2.65		
R 8 =	-6.98	D 8 =	1.25	N 4 = 1.805181	ν 4 = 25.4
R 9 =	-12.54	D 9 =	0.80		
R10 =	57.05	D10 =	4.71	N 5 = 1.583126	ν 5 = 59.4
* R11 =	-12.26	D11 =	可変		
* R12 =	-12.92	D12 =	2.51	N 6 = 1.677900	ν 6 = 55.3
R13 =	-221.05				

可変間隔＼焦点距離	31.10	59.64	89.16
D 4	0.57	8.54	13.57
D 6	9.02	9.95	12.95
D11	11.19	4.26	1.27

非球面係数

11面

A=0　　B=8.944 e-05　C=4.050 e-07　D=8.463 e-09　E=-1.212 e-10

12面

k=-4.367 e-01　A=0　B=5.317 e-05　C=5.018 e-07　D=-5.159 e-09　E=1.630 e-11

【0031】　　【外3】

数値実施例３

f = 31.10～ 89.16　Fno= 3.91 ～ 8.87　2ω=69.1 ～ 27.3

R 1 = 124.77	D 1 = 3.87	N 1 = 1.516330	ν 1 = 64.2
R 2 = -54.04	D 2 = 0.14		
R 3 = -49.90	D 3 = 1.50	N 2 = 1.805181	ν 2 = 25.4
R 4 = -596.11	D 4 = 可変		
R 5 = 13.40	D 5 = 3.47	N 3 = 1.621021	ν 3 = 35.3
R 6 = 20.18	D 6 = 可変		
R 7 = 絞り	D 7 = 2.55		
R 8 = -9.02	D 8 = 1.25	N 4 = 1.805181	ν 4 = 25.4
R 9 = -12.85	D 9 = 0.61		
R10 = 58.05	D10 = 4.71	N 5 = 1.583125	ν 5 = 59.4
* R11 = -12.16	D11 = 可変		
* R12 = -12.80	D12 = 2.51	N 6 = 1.677900	ν 6 = 55.3
* R13 = -195.58			

可変間隔＼焦点距離	31.10	59.85	89.16
D 4	1.00	7.70	13.65
D 6	2.98	9.97	12.93
D11	11.23	4.24	1.28

非球面係数

11面

A=0　　B=1.020 e-04　C=1.993 e-07　D=1.204 e-08　E=-1.487 e-10

12面

k=-2.715 e-01　A=0　B=5.984 e-05　C=6.269 e-07　D=-4.540 e-09　E=7.058 e-12

19面

A=0　　B=-5.780 e-06　C=9.172 e-08　D=-3.338 e-10　E=7.555 e-14

【００３２】

【発明の効果】本発明によれば以上のように、全体として４つのレンズ群より構成し、変倍における各レンズ群の移動条件や屈折力等を適切に設定することにより、広角端の撮影画角が７０°程度、変倍比３．０程度の全変倍範囲にわたり高い光学性能を有したズームレンズを達成することができる。

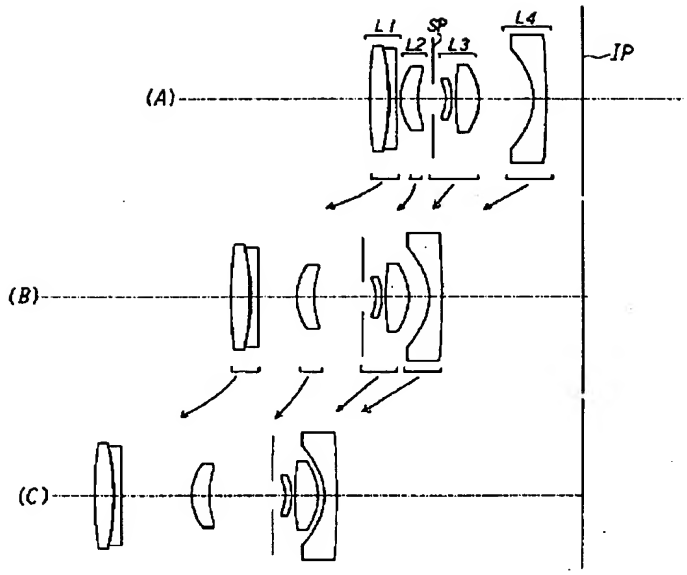
【図面の簡単な説明】

【図１】本発明の数値実施例１のレンズ断面図
【図２】本発明の数値実施例２のレンズ断面図
【図３】本発明の数値実施例３のレンズ断面図
【図４】本発明の数値実施例１の広角端の収差図
【図５】本発明の数値実施例１の中間の収差図
【図６】本発明の数値実施例１の望遠端の収差図
【図７】本発明の数値実施例２の広角端の収差図
【図８】本発明の数値実施例２の中間の収差図
【図９】本発明の数値実施例２の望遠端の収差図
【図１０】本発明の数値実施例３の広角端の収差図
【図１１】本発明の数値実施例３の中間の収差図
【図１２】本発明の数値実施例３の望遠端の収差図

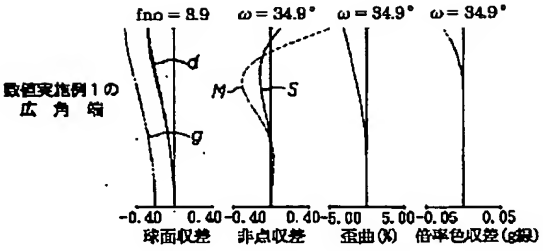
【符号の説明】

Ｌ１　第１群
Ｌ２　第２群
Ｌ３　第３群
Ｌ４　第４群
ＳＰ　絞り
ＩＰ　像面
ｄ　ｄ線
ｇ　ｇ線
Ｓ　サジタル像面
Ｍ　メリディオナル像面

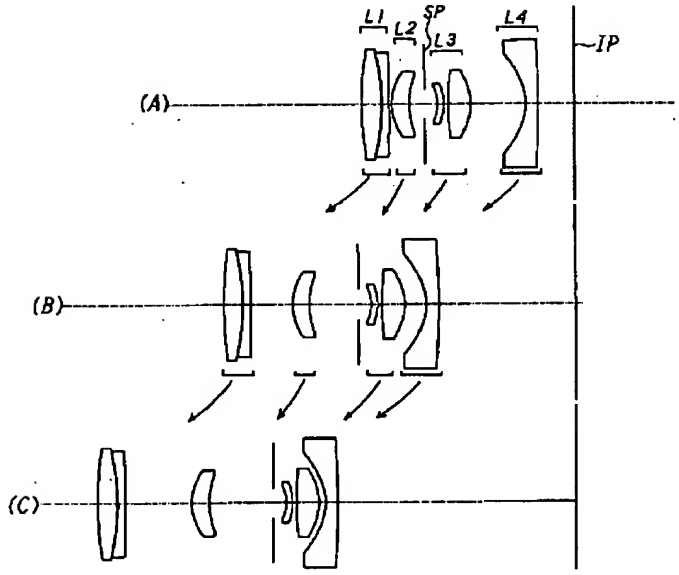
【図１】


L1
SP
L2
L3
L4
IP
(A)
(B)
(C)

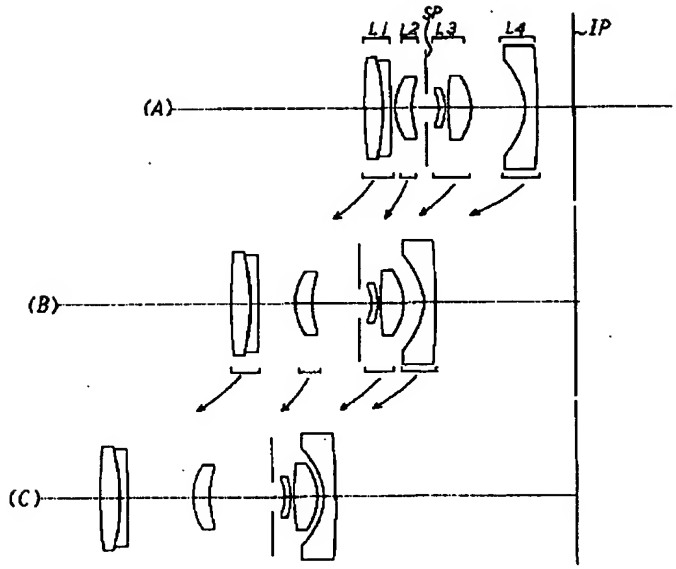
【図４】


fno = 8.9
ω = 34.9°
ω = 34.9°
ω = 34.9°
数値実施例１の
広角端
d
g
M
S
-0.40
0.40
-0.40
0.40
-5.00
5.00
-0.05
0.05
球面収差
非点収差
歪曲(%)
倍率色収差(g線)

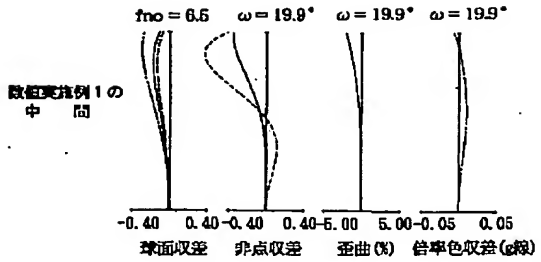
【図２】


L1
L2
SP
L3
L4
IP
(A)
(B)
(C)

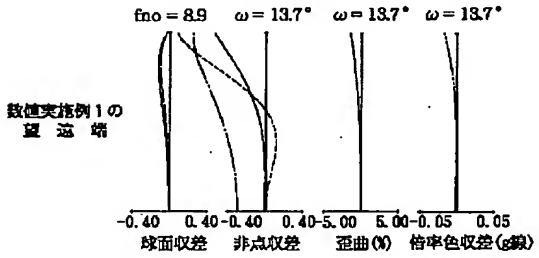
【図3】



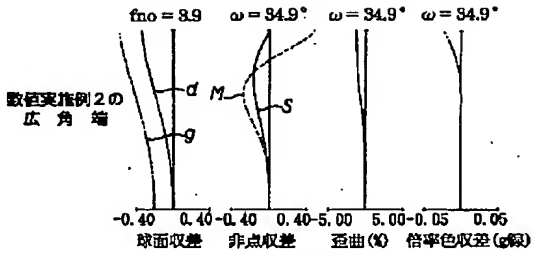
【図5】



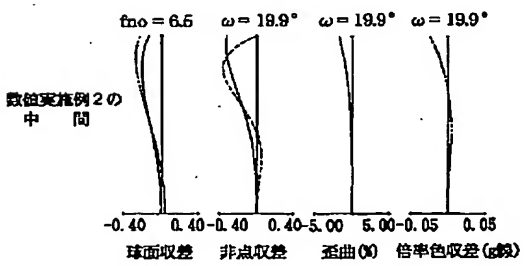
【図6】



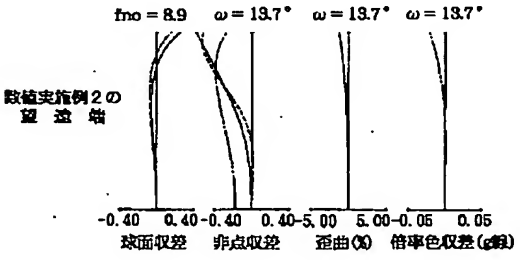
【図7】



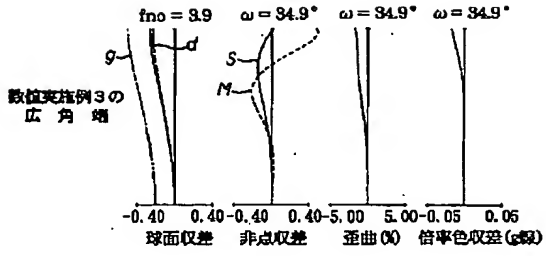
【図8】



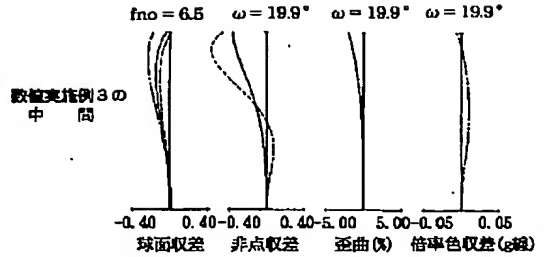
【図9】



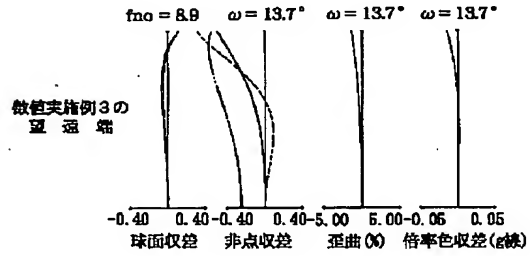
【図10】


fno = 3.9
ω = 34.9°
ω = 34.9°
ω = 34.9°
g
d
S
M
数値実施例3の
広角端
-0.40
0.40
-0.40
0.40
-5.00
5.00
-0.05
0.05
球面収差
非点収差
歪曲(%)
倍率色収差(g線)

【図11】


fno = 6.5
ω = 19.9°
ω = 19.9°
ω = 19.9°
数値実施例3の
中間
-0.40
0.40
-0.40
0.40
-5.00
5.00
-0.05
0.05
球面収差
非点収差
歪曲(%)
倍率色収差(g線)

【図12】


fno = 8.9
ω = 13.7°
ω = 13.7°
ω = 13.7°
数値実施例3の
望遠端
-0.40
0.40
-0.40
0.40
-5.00
5.00
-0.05
0.05
球面収差
非点収差
歪曲(%)
倍率色収差(g線)